

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 December 2005 (08.12.2005)

PCT

(10) International Publication Number
WO 2005/115555 A1

(51) International Patent Classification⁷: A62C 31/07,
39/00

(21) International Application Number:
PCT/PL2004/000101

(22) International Filing Date: 3 December 2004 (03.12.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
P.368269 31 May 2004 (31.05.2004) PL

(71) Applicant (for all designated States except US):
TELESTO SP. Z O.O. [PL/PL]; ul. Ludwinowska
17, PL-02-856 Warszawa (PL).

(72) Inventors; and

(75) Inventors/Applicants (for US only):

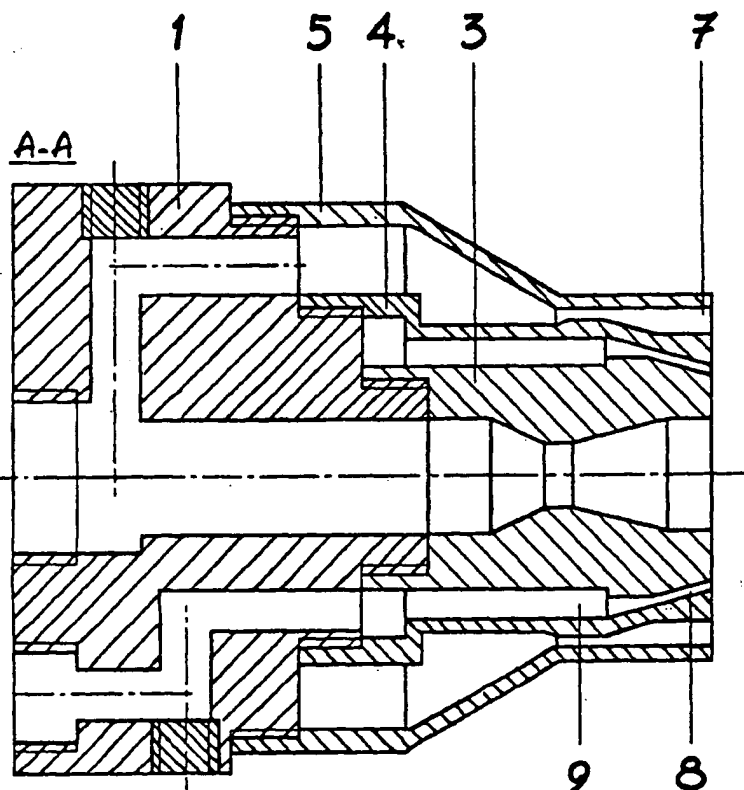
TARNOGRODZKI, Antoni [PL/PL]; Al. Wilanowska
364 m 72, PL-02-665 Warszawa (PL). DUDA, Ludomir
[PL/PL]; ul. Polna 15, PL-05-506 Magdalenka (PL).
HABICH, Bohdan [PL/PL]; ul. Batalionu Miotla
38, PL-01-366 Warszawa (PL). GROSSET, Ryszard
[PL/PL]; ul. Pilsudskiego 26, PL-05-270 Marki (PL).

(74) Agent: WOZNICKI, Jerzy; ul. Noakowskiego 18/20
p.427, PL-00-668 Warszawa (PL).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

[Continued on next page]

(54) Title: WATER MIST GENERATING HEAD



(57) Abstract: Water mist
generating head comprises a
twin-flow body with water and
gas manifold, axially symmetrical
gas nozzles and annular water
port, concentrically situated
between the nozzles. The water
port (9) has water nozzle (8) at
the outlet, convergent towards
the axis and gas nozzles, central
(3) and outer annular (5) having
a Laval nozzle profile with outlet
channel with walls parallel to the
axis. The head is designed for
the purpose of extinguishing fires
and deactivation of chemical and
biological contamination.

WO 2005/115555 A1



(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- with amended claims

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Water mist generating head

The subject of the invention is a head for water mist generation for the purpose of extinguishing fires and deactivation of chemical and biological contamination.

Fire-hose nozzles for generation of water mist, with twin-flow head, where interaction of the two phases – liquid and gas takes place inside the head, are known.

- 5 The gas of high kinetic energy supplied through a gas manifold, provides pneumatic atomization of a liquid stream or film at the outlet of the water port.

In single stream pneumatic atomizers, one gas-stream of any shape acts on one liquid stream. In multi-stream atomizers, liquid stream flowing through an annular passage is surrounded from two sides with gas stream or the gas stream interacts with
10 liquid streams. [Z. Orzechowski, J. Prywer, „Rozpylanie cieczy” (“Atomization of Liquids”), Section IX, page 211, WNT, Warszawa, 1991].

Known are gasodynamic atomizers for water mist generation, with Laval nozzle. The nozzle has a through passage with a cross section area initially decreasing to a throat, and then increasing in the direction of the nozzle outlet. Such nozzle section
15 profile may be obtained through shaping a portion of the nozzle inside surface or through placing a divergent – convergent part inside the nozzle.

In water mist generation heads, currently used in fire-fighting and chemical recovery, there are serious problems in providing the droplet stream with adequate kinetic energy. As the mist quality improves with the reduction of droplet weight, it is
20 necessary to increase the discharge velocity to increase the energy. At the same time, to obtain sufficiently small droplet diameter, the water stream must discharge through very

small holes or break-up on dispersing devices. If, following such processes, the droplets are to have significant speed, it is necessary to use very high pressures as propellant. However, the range of mist fire hose nozzles, in current use, is limited and, in principle, does not exceed 4 to 5 meters. The objective of the solution is the development of a

5 water mist generating head with higher output and range.

Water mist generating head having a twin-flow body with gas and water manifold, axially symmetrical gas nozzles and annular water port, concentrically situated between the nozzles, according to the invention is characterized by the water port that is provided at the outlet, with a water nozzle, convergent to the axis and the

10 central and annular outer gas nozzles have a section of Laval nozzle profile with an outlet channel, having walls parallel to the axis.

It is advantageous if the water port is formed by a sleeve fixed to the body, constituting the inner part of the outer annular nozzle. The sleeve is terminated, at the outlet, with an inside tapered surface, convergent to the axis, and cylindrical surface

15 behind the convergent-divergent part formed on the outside surface. The water port is provided, on the circumference of the inlet part with radial channels connected with the water manifold. The water manifold has, at least, two inlet holes connected with the radial channels by lateral channels.

In the advantageous version, the central nozzle has a cylindrical outlet channel

20 behind the convergent-divergent part formed on the inside surface. In this version, each gas nozzle, central and outside annular nozzle, has an outlet to throat cross section area ratio of 1.5 to 2.5. Moreover, the throat cross section areas of the outer annular nozzle and the central nozzle are equal, what is advantageous, with a tolerance from 0.8 to 1.2 of the cross section area.

In another version, the central nozzle has an annular central outlet channel, whilst a divergent-convergent part with cylindrical outside surface is concentrically located inside the central nozzle. It is advantageous that, if the divergent-convergent part constitutes a circular nozzle with Laval nozzle profile, with an outlet channel having walls parallel to the axis. In such version of the central nozzle, the cross section

25 area of the circular nozzle throat is advantageously equal to the central nozzle throat cross section area, with a tolerance of 0.8 to 1.2 of the cross section area. It is also advantageous if the circular nozzle has a ratio of outlet and throat cross section areas of 1.5 to 2.5, and the circular nozzle has a ratio of outlet and throat cross section areas of 5

30

to 8, and the outer annular nozzle has an outside outlet to throat cross section area ratio of 1.5 to 2.5. Moreover, the cross section area of the outer annular nozzle throat is advantageously twice larger than the sum of cross section areas of the central nozzle throat and the circular nozzle throat with a tolerance of 0.8 to 1.2 of the cross section area.

According to the invention, the head allows obtaining a very high degree of water atomization, below 200 microns, high delivery of atomized liquid and considerable range of mist generated of about 8 to 10 meters. The head features a high fire suppression and extinguishing capabilities, ABCE categories, protection of the fire area and of fire site and smoke absorption. The head allows also effective deactivation of large areas of chemically or biologically contaminated land and also spraying liquids of other specialist applications.

The head, as per invention, is shown in the illustration in an exemplary version, where fig. 1 shows the head in a offset axial section, fig. 2 – view of head from fig. 1 seen from inlet manifold end, and fig. 3 – another version of the head in axial offset section.

Water mist generating head has a twin-flow body 1 with gas and water manifold, axially symmetrical gas nozzles and annular water port 9, concentrically situated between the nozzles. Water port 9 has water nozzle 8 at the outlet, convergent to the axis, and gas nozzles, central 3 and outer annular 5 have a Laval nozzle profile with an outlet channel with walls, parallel to the axis. Water port 9 consists of sleeve 4 fixed to body 1, constituting the inner part of the outer annular nozzle 5. Sleeve 4 is terminated at the outlet with an inner tapered surface, convergent to the axis and with a cylindrical surface behind the divergent-convergent part, formed on the outside surface. On the circumference of its inlet part, water port 9 has radial channels connected to the water manifold. The water manifold has at least two inlet holes connected with radial channels through lateral channels.

In version presented in fig. 1, central nozzle 3 has a cylindrical outlet channel, behind the convergent-divergent part, formed on the inside surface. In this version, the central nozzle 3 and outer annular nozzle 5 has an outlet and throat cross section area ratio of 1.5 to 2.5. Moreover, cross section areas of outer annular nozzle 5 throat and central nozzle 3 throat are advantageously equal, with a tolerance of 0.8 to 1.2 of cross

section area. Head body 1 has the shape of a stepped cylinder with external thread on the three steps. Central nozzle 3 is screwed onto the first step, of the smallest diameter. Onto the next threaded step, sleeve 4 is screwed. The outer annular nozzle 5 is screwed onto the third step. Nozzle 5 at the inlet, is connected by means of a branch union with
 5 the axial channel in body 1, connected with the gas manifold.

Water is supplied to water port 9 via a lateral manifold, lateral channel and two radial recesses, connected to the water port inlet its outlet. At the outlet of water port 9, water flows out through water nozzle 8. Water outflow velocity has a radial component, pointing towards the axis. As an effect of hydrodynamic forces and gas streams flowing
 10 out of concentric nozzles, there is a very high dispersion of water particles whilst compact mist stream area of high kinetic energy is retained.

In fig. 2, the location of manifold is shown. The gas manifold is located in body 1 centre line and two manifold inlet ports are equidistantly spaced on the circumference of the head.

15 Fig. 3 shows a head version where central nozzle 3 has an annular outlet channel 6. Inside central nozzle 3, divergent – convergent part 2, with cylindrical outside surface on the nozzle outlet is located. Moreover, divergent-convergent part 2 constitutes a circular nozzle with Laval nozzle profile, with an outlet channel with walls parallel to the axis.

20 In such version of the head, the cross section area of the circular nozzle throat is advantageously equal to the cross section area of central nozzle 3 throat. Deviation of the size limit shall not exceed 0.8 to 1.2 of the nominal dimension. In this head version, the circular nozzle has an outlet to throat cross section ratio of 1.5 to 2.5, expressed by the following formula:

25 $d^2 / d_o^2 = 1.5 + 2.5$

where: d – outlet diameter, d_o – throat diameter.

Central nozzle 3 has a central annular outlet 6 cross section area to throat cross section area of 5 to 8, expressed by the following formula:

30 $(D_3^2 - D_1^2) / (D_3^2 - D_2^2) = 5 + 8$

where: D_1 – outlet inside diameter, D_2 – throat diameter, D_3 – outlet outside diameter.

Outer annular nozzle 5 has an outlet cross section area to throat cross section area ratio of 1.5 to 2.5, expresses by the following formula:

$$(D_6^2 - D_4^2) / (D_6^2 - D_5^2) = 1.5 \div 2.5$$

where: D_4 – outlet inside diameter, D_5 – throat diameter, D_6 – outlet outside diameter.

5

Moreover, the cross section area of the outer annular nozzle 5 throat is twice larger than the sum of cross section areas of central nozzle 3 and of circular nozzle throats. The deviation of the size limit should not exceed 0.8 to 1.2 of the nominal size of such cross section area. Cross section areas of circular nozzle throat and central annular nozzle 3 are equal to a tolerance of 20%.

10

Cross section area of annular nozzle 5 throat is twice larger than the throat cross section area in other nozzles, with a tolerance to within 20%.

In the head, shown in fig.3, body 1 is in the shape of a stepped cylinder with male thread on three consecutive steps. The first step, of the smallest diameter, has both male and female thread. Female thread is cut in the axial channel, connected with the gas manifold. Divergent-convergent part 2, provided with its inlet part with holes, through which the gas flows from the axial channel to central nozzle 3 having an annular outlet channel 6, is screwed onto the female thread. The central nozzle is screwed onto the male thread. Onto the next threaded step, sleeve 4 is screwed. Outer annular nozzle 5 is screwed onto the last threaded step. This nozzle is connected, at the inlet by means of a branch union with the axial channel in body 1, connected with the gas manifold. In its divergent-convergent part 2, circular nozzle may be provided with a plug for restricting or closing the cross section of this nozzle outlet channel.

15

20

Compressed gas and air in particular, supplied to the gas manifold in the axis of body 1 flows through the axial channel to the circular nozzle and central nozzle 3 and through the means of a branch union to the outer nozzle 5. Arrow P in fig.2 indicates air inlet, arrow W indicates water inlet. Water is supplied to water port 9 through the lateral manifold, lateral channel and two radial recesses connected with its inlet. Symmetrical spacing of these recesses around the axis allows appropriate filling of the port throughout its periphery. At the outlet of water port 9, water flows out through water nozzle 8. Water outflow velocity has a radial component pointed towards the axis.

25

30

In effect of hydrodynamic forces and gas streams flowing out of concentrically arranged nozzles, very high diffusion of water particles is achieved while retaining a

compact area of the generated mist of high kinetic energy. The mass of water mist generated by the head does not consist of water mass only, but also of air mass. Due to that, the kinetic energy of mist generated is increased to such extent that it is possible to direct the front of the mist stream to a distance of 8 to 10 meters, what is a satisfactory distance when extinguishing fires. The effectiveness of the head as per the invention may be improved through the use of additives increasing the density of water, supplied to the head, such like salt solutions, in particular NaCl. Introduction of water solutions or other substances, less volatile than water, to the flame zone improves the effectiveness of extinguishing flames, and evaporated solid particles remaining in the fire area constitute an additional fire suppression agent.

Claims

1. Water mist generating head, having a twin-flow body, with water and gas manifold, axially symmetrical gas nozzles and annular water port, concentrically located between the nozzles, characterised in that the water port /9/ has a water nozzle /8/ at the outlet, convergent towards the axis, and the gas nozzles, central /3/ and outer annular /5/, have a Laval nozzle profile with an outlet channel with walls parallel to the axis.
2. Head as claimed in Claim 1, characterized in that the water port /9/ is constituted by a sleeve /4/ fixed to the body /1/, being the inner part of the outer annular nozzle /5/.
3. Head as claimed in Claim 2, characterized in that the sleeve /4/ is terminated at the outlet with an inside taper convergent towards the axis and cylindrical surface behind the divergent-convergent part formed on the outside surface.
4. Head as claimed in Claim 1, characterized in that the water port /9/ has radial channels on the circumference of the inlet part, connected to the water manifold.
5. Head as claimed in Claim 4, characterized in that the water manifold has at least two inlet ports, connected with the radial channels via lateral channels.
6. Head as claimed in Claim 1, characterized in that the central nozzle /3/ has a cylindrical outlet channel behind the convergent-divergent part formed on the inside surface.
7. Head as claimed in Claim 1, characterized in that the central nozzle /3/ has an annular central outlet channel /6/ whilst divergent-convergent part /2/ with cylindrical outside surface at the nozzle outlet is installed concentrically inside the central nozzle /3/.

8. Head as claimed in Claim 7, characterized in that the divergent-convergent part /2/ constituting a circular nozzle with Laval nozzle profile, with outlet channel having wall parallel to the axis.
9. Head as claimed in Claim 8, characterized in that the cross section area of circular nozzle throat is advantageously equal to cross section area of central nozzle /3/ throat, with a tolerance of 0.8 to 1.2 of cross section area.
10. Head as claimed in Claim 8, characterized in that the circular nozzle throat has outlet cross section area to throat cross section ratio of 1.5 to 2.5, central nozzle has annular outlet channel /6/ outlet to throat cross section ratio of 5 to 8, and outer annular nozzle /5/ has an outlet to throat cross section area ratio of 1.5 to 2.5.
11. Head as claimed in Claim 8, characterized in that the cross section area of outer annular nozzle throat /5/ is advantageously twice the sum of cross section areas of central nozzle /3/ throat and circular nozzle, with a tolerance of 0.8 to 1.2 of cross section area.
12. Head as claimed in Claim 2, characterized in that the central gas nozzle /3/ and outer annular nozzle /5/ have a cross section area ratio of the outlet to throat of 1.5 to 2.5.
13. Head as claimed in Claim 2, characterized in that the cross section areas of outer annular nozzle /5/ throat and central nozzle /3/ are advantageously equal, with a tolerance of 0.8 to 1.2 of cross section area.

AMENDED CLAIMS

[received by the International Bureau on 07 June 2005 (07.06.2005): original claims 1-13 have been replaced by amended claims 1-13].

Claims

1. Water mist generating head having a twin-flow body, with water and gas manifold, with two gas nozzles, a first central one, and a second annular one concentric to the first one, with an annular water port concentrically disposed between the two gas nozzles, characterised in that the water port /9/ has a water nozzle /8/ at the outlet, convergent towards the axis of the central gas nozzle /3/, and the two gas nozzles, central one and annular gas nozzle /5/, have a Laval nozzle profile with an outlet channel with walls parallel to the axis.
2. Head as claimed in Claim 1, characterized in that the water port /9/ is constituted by a sleeve /4/ fixed to the body /1/, being the inner part of the annular gas nozzle /5/.
3. Head as claimed in Claim 2, characterized in that the sleeve /4/ is terminated at the outlet with an inside taper convergent towards the axis of central gas nozzle /3/ and cylindrical surface behind the divergent-convergent part formed on the outside surface.
4. Head as claimed in Claim 1, characterized in that the water port /9/ has radial channels on the circumference of the inlet part, connected to the water manifold.
5. Head as claimed in Claim 4, characterized in that the water manifold has at least two inlet ports, connected with the radial channels via lateral channels.
6. Head as claimed in Claim 1, characterized in that the central gas nozzle /3/ has a cylindrical outlet channel behind the convergent-divergent part formed on the inside surface.
7. Head as claimed in Claim 1, characterized in that the central gas nozzle /3/ has an annular outlet channel /6/ whilst divergent-convergent part /2/ with cylindrical outside surface at the nozzle outlet is installed concentrically inside the central gas nozzle /3/.

8. Head as claimed in Claim 7, characterized in that the divergent-convergent part /2/ constituting a circular nozzle with Laval nozzle profile, with outlet channel having wall parallel to the axis.
9. Head as claimed in Claim 8, characterized in that the cross section area of circular nozzle throat is advantageously equal to cross section area of the central gas nozzle /3/ throat, with a tolerance of 0.8 to 1.2 of cross section area.
10. Head as claimed in Claim 8, characterized in that the circular nozzle throat has outlet cross section area to throat cross section ratio of 1.5 to 2.5, the central gas nozzle /3/ has an annular outlet channel /6/ outlet to throat cross section ratio of 5 to 8, and the annular nozzle /5/ has an outlet to throat cross section area ratio of 1.5 to 2.5.
11. Head as claimed in Claim 8, characterized in that the cross section area of the annular nozzle /5/ throat is advantageously twice the sum of cross section areas of central gas nozzle /3/ throat and circular nozzle, with a tolerance of 0.8 to 1.2 of cross section area.
12. Head as claimed in Claim 2, characterized in that the central gas nozzle /3/ and the annular gas nozzle /5/ have a cross section area ratio of the outlet to throat of 1.5 to 2.5.
13. Head as claimed in Claim 2, characterized in that the cross section areas of the annular gas nozzle /5/ throat and the central gas nozzle /3/ are advantageously equal, with a tolerance of 0.8 to 1.2 of cross section area.

1/2

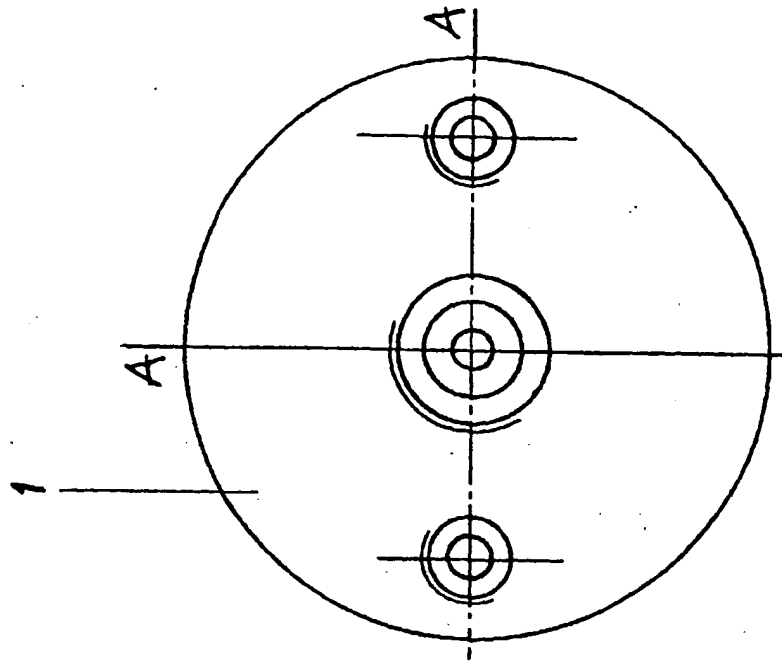


FIG. 2

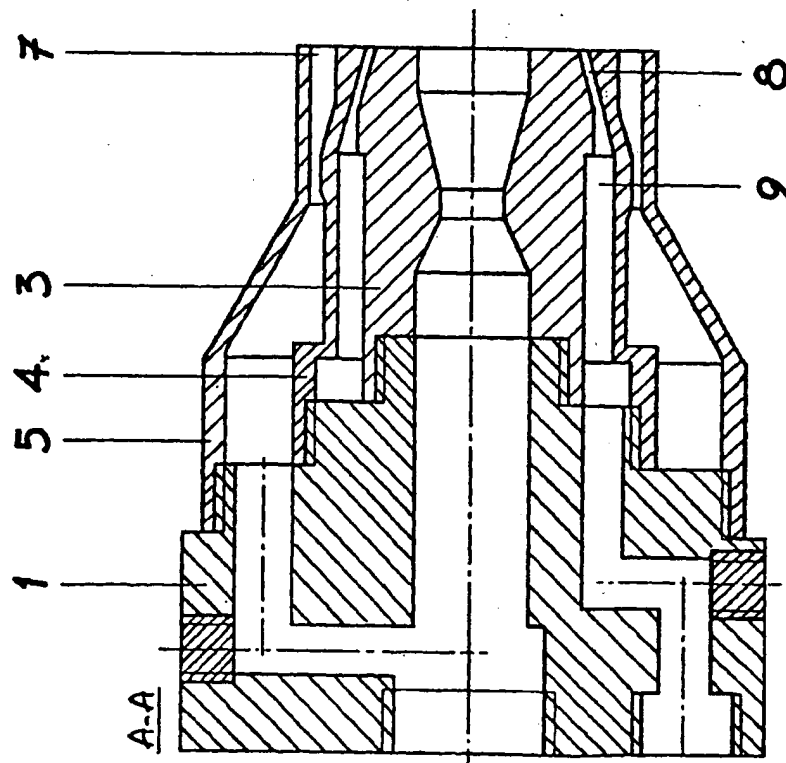


FIG. 1

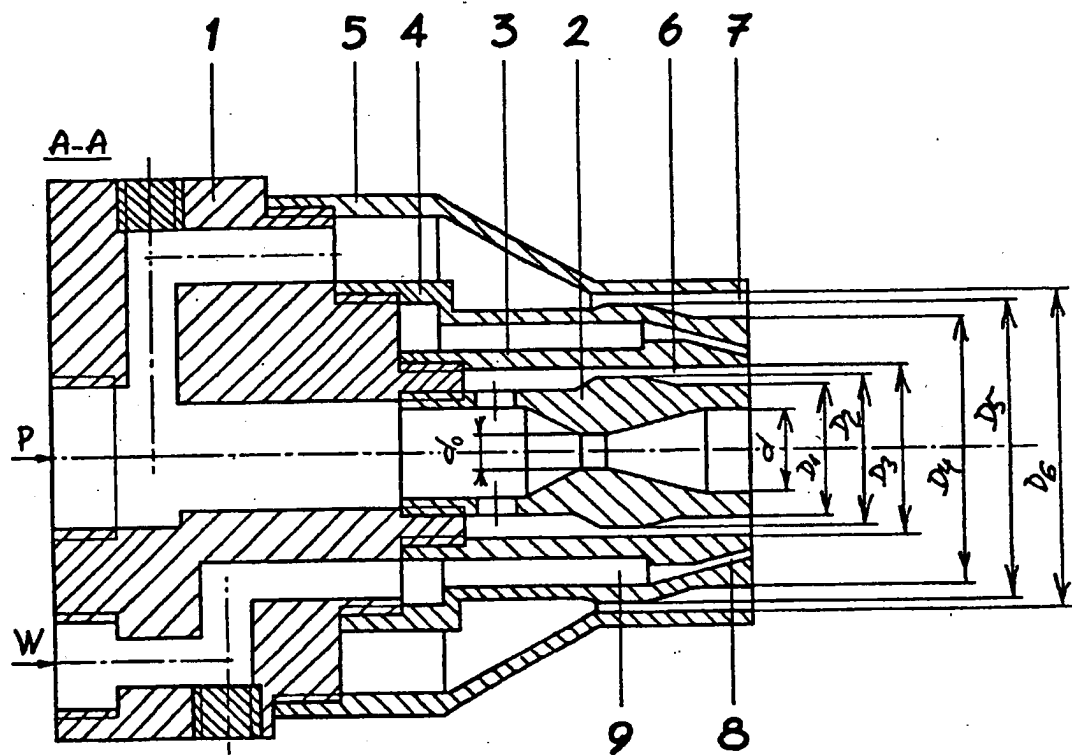


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/PL2004/000101

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A62C31/07 A62C39/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A62C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 295 10 976 U1 (BROEMME, ALBRECHT, DIPL.-ING., 12203 BERLIN, DE) 31 August 1995 (1995-08-31) the whole document	1-13
A	WO 97/38757 A (NATIONAL FOAM, INC) 23 October 1997 (1997-10-23) the whole document	1-3
A	EP 0 505 100 A (CCA, INC) 23 September 1992 (1992-09-23) the whole document	1-13
A	US 5 597 044 A (ROBERTS ET AL) 28 January 1997 (1997-01-28) the whole document	1-13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

6 April 2005

Date of mailing of the international search report

14/04/2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Neiller, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/PL2004/000101

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 29510976	U1	31-08-1995	AU 3564095 A WO 9702863 A1	10-02-1997 30-01-1997
WO 9738757	A	23-10-1997	US 5779158 A AU 732533 B2 AU 2671997 A BR 9708717 A CA 2251760 A1 CN 1216477 A ,C EP 0894020 A1 ID 19860 A WO 9738757 A1	14-07-1998 26-04-2001 07-11-1997 03-08-1999 23-10-1997 12-05-1999 03-02-1999 13-08-1998 23-10-1997
EP 0505100	A	23-09-1992	US 5167285 A AT 131082 T AU 645942 B2 AU 1299392 A CA 2062864 A1 DE 69206454 D1 DE 69206454 T2 DK 505100 T3 EP 0505100 A1 ES 2084274 T3 GR 3018420 T3 JP 3450348 B2 JP 5115576 A MX 9201254 A1 US 5275243 A	01-12-1992 15-12-1995 27-01-1994 24-09-1992 22-09-1992 18-01-1996 18-07-1996 04-03-1996 23-09-1992 01-05-1996 31-03-1996 22-09-2003 14-05-1993 01-10-1992 04-01-1994
US 5597044	A	28-01-1997	US 5495893 A AU 2547295 A CA 2189147 A1 CN 1147771 A EP 0758915 A1 FI 964503 A JP 10500041 T NO 964398 A WO 9530452 A1	05-03-1996 29-11-1995 16-11-1995 16-04-1997 26-02-1997 08-11-1996 06-01-1998 11-12-1996 16-11-1995